Approved for Entry

TUNEABLE PHASE SHIFTER AND/OR ATTENUATOR

The present invention relates to a phase shifter and/or attenuator and in particular to an optically tuneable phase shifter and/or attenuator capable of operating in the microwave, millimeter and sub-millimeter wave spectrum. The phase shifter and/or amplitude attenuator may be used in a wide range of applications including, but not limited to, phase-shift-keying circuitry, terahertz imaging, transceivers and phased-array antennas.

As far as the sub-millimeter range is concerned, terahertz technology been primarily been used in the fields of terrestrial astronomy and earth observation. However, many materials that are opaque in the optical and infrared regions are transparent to terahertz waves (0.1 THz to 10 THz). Applications for terahertz technology have thus recently expanded to include areas such as aerial navigation where terahertz waves are able to penetrate clouds and fog, medical imaging where body tissue can be examined without using potentially harmful ionizing radiation, and non-invasive security systems for use at airports and ports in which the terahertz waves are able to pass through clothing and materials normally opaque to infrared.

Due to the sub-millimeter wavelengths of terahertz waves, the required dimensions and accuracy of components such as antennas, waveguides, lenses, mirrors etc. make fabrication difficult and costly using conventional manufacturing techniques.

In the millimeter waveband, ferroelectric phase shifters are often employed in which the phase of the signal is shifted by varying the permitivity of the ferroelectric material by means of an applied electric field. However, ferroelectric phase shifters suffer from substantial power losses, signal distortions and noise, and offer only discrete steps.

An optically activated waveguide type phase shifter and/or attenuator has been disclosed in Patent No. US 5,099,214 (ROSEN et al.). This device comprises a semiconductor slab that is attached to an inside wall of waveguide and which receives light from an illumination source disposed in an aperture of an inside wall opposite inside wall. In US Patent No. 4,263,570 (DE FONZO), a piece of semiconductor material is attached to an inside wall of a waveguide and an inside surface of said piece is lit from outside by a light source through an aperture in a wall opposite inside wall.